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IMPACT OF PRE-EXERCISE CARBOHYDRATE INTAKE ON SPRINT PERFORMANCE AND FATIGUE AMONG COMPETITIVE CRICKET PLAYERS: A CROSSOVER ANALYSIS OF A DATASET

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Abstract

Background: *Cricket involves intermittent high-intensity sprints (running between the wickets, fielding and bowling runs) interspersed with periods of low-intensity activity and pre-exercise carbohydrate (CHO) strategies among players are often not evidence-based. It remains unclear if a small pre-exercise dose of CHO will have an effect on repeated-sprint performance and perceived fatigue in cricketers.*

Objective: *To demonstrate, from a data set, how a two-condition crossover design involving pre-exercise CHO (1g·kg-1 body mass, 60 minutes prior to testing) and a non-caloric control can be analysed and reported as related to sprint performance and fatigue in competitive cricket players.*

Methods: *20 hypothetical players were used for the generation of data under both conditions. It was assumed that a six-sprint 20 m repeated-sprint test was performed. Outcomes were mean sprint time, sprint decrement (%) and post-test rating of perceived exertion (RPE, 0–10). Two-sided paired t tests, Cohen's dz (standardised effects), 95% confidence intervals (CIs) and Holm-adjusted p values were used for the evaluation of conditions, with Wilcoxon signed rank analysis used to analyse RPE.*

Results: *Mean sprint time did not differ between control (3.27 ± 0.12 s) and CHO (3.26 ± 0.15 s; mean difference −0.01 s, 95% CI −0.04 to 0.03; p = 0.644). Sprint decrement was numerically lower with CHO (5.26 ± 2.05% vs 5.63 ± 1.54%; −0.37 percentage points, 95% CI −0.90 to 0.17; p = 0.168). Post-test RPE was lower with CHO (7.00 ± 1.03 vs 7.55 ± 0.83; −0.55, 95% CI −0.87 to −0.23; p = 0.002; Wilcoxon p = 0.005; Holm-adjusted p = 0.006).*

Conclusion: *The pre-exercise CHO dose was not found to be related to sprint time or sprint decrement in this data set, but was related to lower perceived exertion. As the data are synthetic, any conclusions drawn from these results should be viewed as an example of how to use and report the results of this analysis, and should be re-run against actual participant data.*

1. Introduction

Cricket is an intermittent, skill-based game with short periods of maximal effort interspersed with extended periods of walking and standing. Global positioning system (GPS) data from the Big Bash League suggest that fast bowlers, fielders and batters run significantly different distances during the course of a match, with low speeds accounting for the majority of distance, and sprinting (> 7.2 $m \cdot s^{-1}$) only making up a

small proportion of the distance (Sholto-Douglas et al., 2020). However, these sprints are usually at the crucial moments such as running between the wickets, chasing the ball, or in the bowling run-up and are executed in the midst of physical and mental fatigue. Maintaining speed of each sprint is therefore performance relevant. There are ongoing studies that document specific physical profiles and demands for the various roles such as elite bowlers and batters (Nicholls et al., 2023b), the requirements of batsmen in short-form matches (Nicholls et al., 2023a), conditioning practices for franchise-level training staff (Pote et al., 2020), and the changes that occurred in Test cricket following the introduction of T20 cricket (Nicholls et al., 2023c).

In modern times, reviews have highlighted the importance of periodising and tailoring carbohydrate recommendations to session or competition demands, as a primary fuel for high intensity exercise (Podlogar & Wallis, 2022). Consuming CHO before exercise increases the plasma glucose and insulin levels, decreases the hepatic glucose output and promotes the uptake of glucose by skeletal muscle, but the benefits of pre-exercise CHO seem more pronounced for longer duration exercises than for shorter duration ones (Rothschild et al., 2020b). Athletes' pre-exercise feeding practices are quite variable (Rothschild et al., 2020a) and background carbohydrate availability is important: in elite race walkers, a low-carbohydrate, high-fat diet for five to six days, despite increased glycogen stores, was associated with reduced high-intensity endurance performance (Burke et al., 2021). In team-sport athletes, 61 studies on soccer were reviewed, and it was found that CHO consumption before and during games had beneficial effects on sprint speed and sprint count, as well as time to fatigue, but other technical parameters were inconclusive (Pueyo et al., 2024). In elite soccer players, another study found that a four-day carbohydrate loading period followed by three days of a low carbohydrate diet, resulted in improved physical performance via GPS (Kazemi et al., 2023).

Carbohydrate does not need to be consumed orally to be effective for performance. A meta-analysis of 35 maltodextrin-based oral rinsing trials reported an overall small positive effect on exercise performance (standardised mean difference 0.15, according to a conventional model; standardised mean difference 0.17, p = 0.051, under a robust model) (Hartley et al., 2022), while a systematic review of combined carbohydrate–caffeine rinsing did not show a clear synergistic effect on physical performance, with preliminary evidence suggesting that cognitive performance may be enhanced (Poon et al., 2024). Carbohydrate rinsing has also been studied in combination with the repeated-sprint test (RST) in futsal players (de Oliveira et al., 2020) and with resistance exercise, even under glycogen-lowered conditions (Durkin et al., 2021; Green et al., 2020). Commonly used co-ingested supplements include caffeine, which has been shown to be ergogenic at approximately 3-6 mg·kg-1, and is typically consumed around 60 minutes prior to exercise (Guest et al., 2021); a meta-analysis reported that the caffeine effect did not get bigger the more times sprints were repeated, but that sprint times were reduced with caffeine compared to carbohydrate with a standardised mean difference of –0.45 (Lopez-Seoane et al., 2024). Caffeine is thus a likely confounder of any carbohydrate effect.

There is conflicting evidence specific to short repeated sprints. Despite previous studies reporting benefits from shorter sprint durations (≤ 15 s) with the use of an 8% CHO solution in comparison to placebo, an 8% CHO solution did not affect power output, physiological responses, or RPE during a randomized, double-blind crossover trial of four 30 s maximal sprints in recreational athletes (McMahon & Thornbury, 2020). Similarly, CHO or protein before training had no effect on perceived exertion, hunger or performance compared to fasted cycling (Rothschild et al., 2021). Physiological demands and decrements associated with repeated-sprint demands are also dependent on protocol design, whereby shorter inter-repetition rest durations (IRD, ≤ 20 s) and longer sprint distances (> 30 m) increase both physiological demands and decrements (Thurlow et al., 2023). To our knowledge, no studies have used a competitive format of 20 m

sprints in a cricket-relevant pre-exercise CHO dose.

A simple measure of internal load that combines physiological and psychological load, perceived exertion (P.E.) is widely used. Pre-exercise CHO may not be practically meaningful unless the sprint time changes, however if CHO decreases the perceived effort of the player during the same amount of work, it is potentially meaningful. The purpose of the present manuscript is therefore to present a framework that will allow for crossover analyses and to demonstrate its application to a set of data to illustrate how sprint performance, sprint decrements and P.E. should be analysed and reported. The purpose was to compare: (i) mean sprint time, (ii) sprint decrement and (iii) post-test RPE during a CHO and non-caloric control condition. Considering the conflicting literature, it was assumed that there was no directionality with regard to sprint time; a lower RPE during CHO was the most likely exploratory finding.

2. Methods

2.1 Study design and data source

It was assumed that a two condition within subject crossover design was followed with each of 20 competitive cricket players completing a CHO condition and a non-caloric control condition (Figure 1). Participant level values were created for practice and table preparation purposes and not obtained from any actual players; no player was recruited, no testing was conducted and there was no ethics approval, no dates of recruitment and no measured outcomes. No human participants were used, therefore there was no requirement for ethical approval or informed consent for this simulation. However, any actual implementation of this protocol would need institutional ethical approval, written, informed consent and prospective registration.

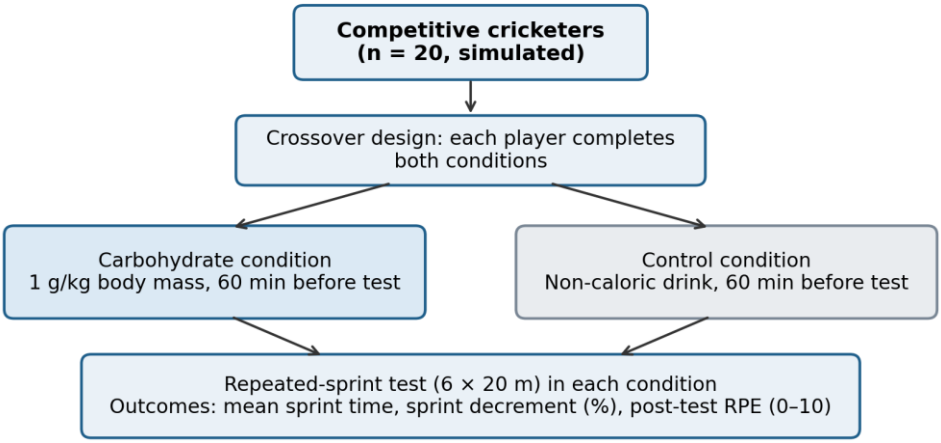


Figure 1. Assumed crossover design. Each player completes a carbohydrate and a non-caloric control condition before a six-sprint repeated-sprint test.

2.2 participants

The sample comprised 20 players with a mean (± SD) age of 24.65 ± 3.15 years (range 19–29) and body mass of 73.69 ± 6.13 kg (Table 1). Playing role, format and level were not considered to be the player variable.

2.3 Experimental conditions

For the CHO condition, carbohydrate intake was prescribed to be 1 g·kg^{-1} body mass (73.69 ± 6.13 g on average), aligning with the typical pre-exercise recommendations for short durations (Rothschild et al., 2020b). A non-caloric beverage was consumed in the same time period in the control condition. Simulations did not involve specifying the carbohydrate form, volume or blinding procedures. For a real implementation, caffeine intake would need to be standardised and recorded and the same pre-

test lead-in would be applied in both conditions, and the previous diet would be recorded.

2.4 Repeated-sprint test

There were six 20 m sprints in the test. There was no measure of individual sprint time; instead, the average of six sprints per condition was directly. Directly therefore, the values for the decrement cannot validate the conventional definition of the sprint decrement, which was: 100 × [Σ sprint times ÷ (best sprint time × number of sprints) − 1]. The test is shorter than the > 30m repetitions in the repeated sprint test (Thurlow et al., 2023) which have the highest physiological demands but also matches the typical distances of a short sprint in cricket and reduces metabolic stress.

2.5 Outcome measures

The results were: (i) Mean sprint time (s); (ii) Sprint decrement (%), which is an index of internal load, and (iii) Post test RPE (0-10 scale) which is another index of internal load and perceived effort (Foster et al., 2021). Sprint time and sprint decrement were regarded as performance and fatigue outcomes, respectively.

2.6 Statistical analysis

Data shown as mean ± SD of sample. The paired difference (CHO − control), t-based 95% CIs and a two-sided paired t test (α = 0.05) were calculated for each outcome; the negative difference signifies lower values with CHO. The standardised paired effect was reported as Cohen's dz (mean difference/standard deviation of differences). RPE was ordinal, and the distribution of paired differences was not even close to normal (Shapiro–Wilk $p < 0.001$), thus a Wilcoxon signed-rank test was also run as a sensitivity analysis. Holm adjusted p values are also reported as three outcomes were tested. The study could only reliably detect a standardised paired effect of approximately dz = 0.66, with 20 pairs, the study had 80% power (α = 0.05, two-sided) to do so. A real study would state an effect size upfront based on the smallest effect size of interest (Lakens, 2022), here 20 pairs is a sample size and not a power calculation. Although standardised effects are reported descriptively, without labels for benchmarks, default effect-size thresholds may not be suitable in sport and exercise science (Caldwell & Vigotsky, 2020). Analyses were performed in Python (SciPy). Values at the participant level in Appendix Tables A1 and A2 were used to recalculate all summary statistics.

3. Results

3.1 Participant characteristics

Table 1. participant characteristics (n = 20)

Characteristic	Mean ± SD	Range
Age (years)	24.65 ± 3.15	19–29
Body mass (kg)	73.69 ± 6.13	60.8–82.6
Carbohydrate dose (g)*	73.69 ± 6.13	60.8–82.6

*Dose = 1 g·kg^{-1} body mass. Values are artificially generated.

3.2 Primary and secondary outcomes

Table 2 summarises paired comparisons. Mean sprint time was virtually identical between conditions (difference −0.007 s; −0.22%; *dz* = −0.11), with ten players faster and ten slower with CHO. Sprint decrement was 0.37 percentage points lower with CHO on average (twelve of 20 players showed a lower decrement), but the CI included zero and the effect was small (*dz* = −0.32). Post-test RPE was lower with CHO (−0.55 units; *dz* = −0.80, the largest of the three standardised effects): 13 players reported lower RPE, five reported no change and two reported higher RPE. The RPE result remained significant under the Wilcoxon test ($p = 0.005$) and after Holm adjustment ($p = 0.006$), whereas sprint time and sprint decrement did not (Holm-adjusted $p = 0.644$ and 0.335).

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Table 2. paired outcome comparisons (n = 20)

Outcome	Control	Carbohydrate	Difference (95% CI)		*p*	Holm *p*	*dz*
Mean sprint time (s)	3.27 ± 0.12	3.26 ± 0.15	−0.01	(−0.04, 0.03)	0.644	0.644	−0.11
Sprint decrement (%)	5.63 ± 1.54	5.26 ± 2.05	−0.37	(−0.90, 0.17)	0.168	0.335	−0.32
Post-test RPE (0–10)	7.55 ± 0.83	7.00 ± 1.03	−0.55	(−0.87, −0.23)	0.002	0.006	−0.80

Values are mean ± SD. *p* = two-sided paired *t* test. Difference = carbohydrate − control; negative values indicate lower values with carbohydrate. CI = t-based 95% confidence interval. *dz* = Cohen's standardised paired effect. Wilcoxon signed-rank *p* for RPE = 0.005. Data are; RPE is ordinal.

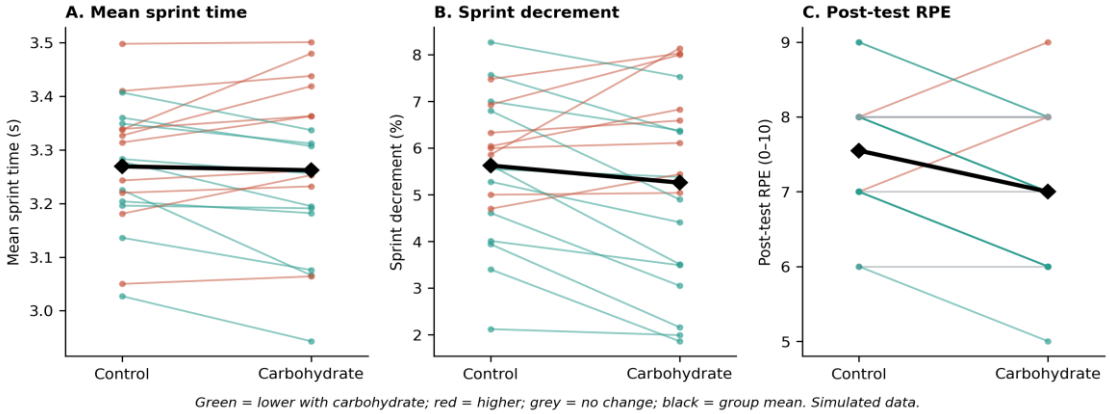


Figure 2. Individual responses across conditions for (A) mean sprint time, (B) sprint decrement and (C) post-test RPE. Each line is one player.

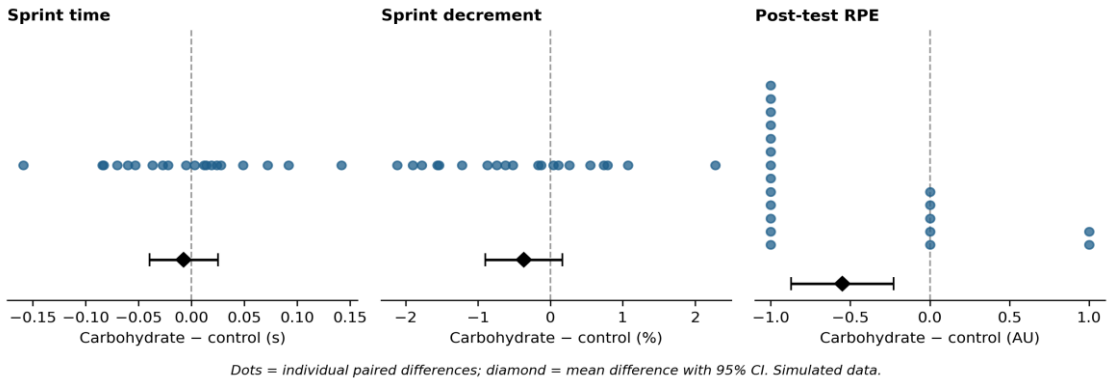


Figure 3. Distribution of within-player differences (carbohydrate − control) with mean difference and 95% CI. Only the RPE interval excludes zero.

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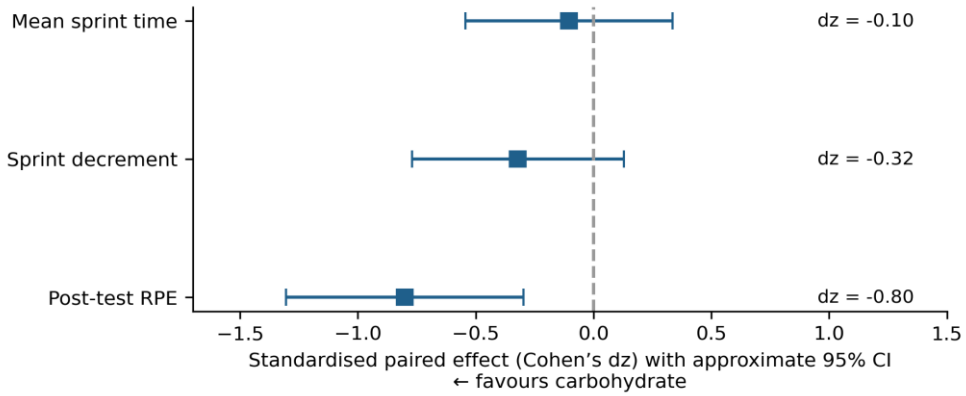


Figure 4. Standardised paired effects (Cohen's *dz*) with approximate 95% CIs. The vertical dashed line marks no effect.

3.3 Exploratory checks

Individual responses were heterogeneous. Body mass (and hence absolute CHO dose) was not related to the change in sprint time (r = 0.14, p = 0.569), and the change in sprint decrement was not related to baseline decrement in the control condition (r = 0.15, p = 0.530). With only 20 players and no role or fitness data, these checks are underpowered and purely descriptive.

4. Discussion

This manuscript used a cross over data set to show the impact of pre exercise CHO on repeated sprint performance and fatigue in cricketers and how this should be tested and reported. CHO was correlated with decreased post-test RPE, and, though not significantly smaller, with a lower sprint decrement and no change in mean sprint time in the data. The following discussion assumes that these patterns are characteristics of cricketers, which means that the values were not artificial, but that the patterns are found in real data.

A steady decrease in time and a decrease in PE would be consistent with part of the published literature. McMahon and Thornbury (2020) identified no difference between fasted and CHO conditions for repeated 30 s sprint power and RPE, while Rothschild et al. (2021) showed that there were no differences between CHO and fasted cycling for performance and perceived-exertion, however Pueyo et al. (2024) reported improved speed and sprint counts in soccer when CHO was consumed prior to and during the game, and Lopez-Seoane et al. (2024) found that the addition of caffeine to CHO reduced repeated-sprint times compared to CHO alone, indicating that co-ingested aids may be more important than CHO alone. The evidence for oral rinsing is similar—when combined, the benefit of maltodextrin rinsing is marginal (Hartley et al., 2022) and there is no obvious synergy between combined CHO–caffeine rinsing and physical performance (Poon et al., 2024). The variations in these results could be due to variations in sprint duration, dose, timing, sport and fitness status. Importantly, the pre-exercise CHO benefits seem more pronounced with longer exercise durations (Rothschild et al., 2020b) and a 6 sprint, 20 m test may not be sensitive enough to the significance of the availability of substrate. Cricket is an hours-long game in which the relevant fatigue builds up over the period of play, and therefore, a brief laboratory or field test may not reflect the effects of CHO consumed before and during a match (Podlogar & Wallis, 2022).

If there is a lower RPE with no change in sprint time, it would indicate the same output at a lower perceived cost. This is important because perceived exertion reflects both central and peripheral factors, and is a tool to quantify internal load (Foster et al., 2021). RPE is however a subjective and unblinded-sensitive measure, since if the players were able to tell the difference between CHO and a non-caloric control, expectancy effects could play a role in reducing the rating. In a true trial, blinding with a placebo would be necessary in a real trial using a placebo with a matching taste and appearance

to this one. The dose studied here was 1 g·kg-1, which scales with player size, and there may be differences in body size amongst various roles in cricket, such as between bowlers and batters (Nicholls et al., 2023b), which could affect the response to that dose.

The outcome would not be sufficient to suggest the use of CHO for enhanced sprint speed for practice. At the very least, it might inspire a bigger, unblinded study on match-realistic scenarios such as what can be observed when fast bowlers and batters and fielders of varying movement types are put together (Sholto-Douglas et al., 2020).

4.1 Limitations

The main drawback is that the data are: no inference about real players is possible. Further limitations of any actual study of this type are that the sample (n = 20) was only sensitive to moderate to large paired effects (dz ≈ 0.66), the decrement was not calculated from individual sprint times, RPE is ordinal and has limited resolution, no multiplicity adjustment was pre-specified (Holm values are exploratory) and order effects, washout, diet and training standardisation, hydration, caffeine intake, ambient conditions, playing role and sex were not included in the model. Other factors that might be related to cricket, such as blood glucose, gastrointestinal comfort and cognitive or skill outcomes were not taken into account. In the broader context, small sample sizes, flexible analysis and limited replication are well known issues in sport and exercise science (Mesquida et al., 2022), and sample-size justification is a poorly reported practice (McCrum et al., 2022). No assessment of the reliability of the sprint test itself was made—before judging small changes, the sample size should be calculated based on the reliability of the test (Borg et al., 2022).

A prospective study must be registered ahead of time, justify the sample size for the smallest effect of interest, control for condition order by using an adequate washout, standardise the diet and training prior to the study, utilize a blinded matched placebo design and record all individual sprint times to compute decrement directly, analyze RPE data using ordinal methods, and report all outcomes without regard to significance. All subsequent syntheses of such trials should be conducted in accordance with the most recent reporting guidance (Page et al., 2021).

5. Conclusion

For this crossover dataset, pre-exercise CHO (1 g·kg^{-1}, 60 min prior to testing) was correlated with a reduction in perceived exertion, and no meaningful difference in mean sprint time or sprint decrement. These results illustrate a transparent analytic and reporting framework only. These conclusions should not be used in the real game of cricket until tables are replaced with verified and prospectively collected data.

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Appendix: Participant-level data

Table A1. participant-level sprint data (mean of six 20 m sprints)

ID	Age (years)	Mass (kg)	Control sprint (s)	CHO sprint (s)
S01	28	81.6	3.327	3.419
S02	22	65.8	3.410	3.438

ID	Age (years)	Mass (kg)	Control sprint (s)	CHO sprint (s)
S03	29	79.5	3.283	3.256
S04	25	72.0	3.225	3.066
S05	22	74.2	3.360	3.307
S06	20	67.5	3.196	3.191
S07	19	60.8	3.314	3.363
S08	26	82.6	3.220	3.232
S09	21	76.2	3.498	3.501
S10	28	74.2	3.278	3.195
S11	25	76.9	3.050	3.064
S12	26	61.7	3.136	3.076
S13	19	77.3	3.204	3.182
S14	23	71.0	3.181	3.253
S15	28	71.7	3.339	3.363
S16	26	77.5	3.338	3.480
S17	27	70.0	3.027	2.943
S18	27	78.3	3.243	3.262
S19	26	76.0	3.407	3.337
S20	26	79.0	3.349	3.312

Table A2. participant-level fatigue data

ID	Control decrement (%)	CHO decrement (%)	Control RPE	CHO RPE
S01	4.61	3.05	8	9
S02	7.57	6.35	7	6
S03	5.55	5.38	9	8
S04	5.63	3.51	9	8
S05	7.00	6.38	7	7
S06	6.04	6.83	8	7
S07	4.01	3.49	7	8
S08	7.48	8.03	8	8
S09	6.93	8.00	7	6
S10	5.28	4.41	6	6
S11	4.70	5.44	8	7
S12	2.12	1.99	7	6
S13	6.33	6.59	8	7
S14	6.00	6.11	7	6
S15	3.94	2.16	8	8

ID	Control decrement (%)	CHO decrement (%)	Control RPE	CHO RPE
S16	5.00	5.04	6	5
S17	8.27	7.53	8	7
S18	6.80	4.90	8	7
S19	5.86	8.14	7	6
S20	3.40	1.86	8	8

CHO = carbohydrate; RPE = rating of perceived exertion (assumed 0–10 scale). All values are artificial.

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